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Review of wireless communication transmission technology

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Abstract. With the advancement of modern science and technology, wireless communication technology has grown rapidly. A number of common standards for wireless data transmission have emerged, primarily for long-distance and short-range wireless communication. This paper compares several common wireless communication transmission technologies, including satellite communication, Bluetooth, WiFi, NFC, etc. Wireless communication technology has now entered the 5G stage. From the previous SMS to the current video conference, the transmission rate and transmission accuracy have been greatly improved. Wi-Fi facilities everywhere in the city, Bluetooth transmission, mobile phone NFC payment, etc. are convenient and improve people's lives. Wireless communication technology also has many applications, such as 5G technology, Internet of Things technology, and the development of artificial intelligence technology.

Keywords: satellite communications, Zig-Bee, Bluetooth, Wi-Fi, NFC.

1. Introduction

Compared to wired transmission, wireless transmission has various benefits. Without the use of cables, wireless signals can be delivered from one transmitter to numerous recipients. The spectrum for wireless communications comprises frequencies from 9kHz to 300,000Ghz. A specific wireless spectrum region is connected to each wireless service. Short-range wireless communication technology and long-distance wireless communication technology are two categories of wireless communication transmission technology. Compared with the existing wireless long-distance communication network (such as the cellular mobile communication network), short-range wireless communication is very different in terms of its basic structure and application level, and the two are also very different in the scope of service and the service (data, voice) [1]. Since the turn of the century, as modern electronic information technology has continued to advance, wireless communication has received more high-tech equipment, changing the effectiveness and quality of its use. The lives of individuals have been greatly impacted by wireless communication. This study will compare and analyze common wireless communication transmission technologies, and also state the advantages and disadvantages of short-range wireless transmission technologies and long-range wireless transmission technologies. By analyzing the application fields of different technologies, we summarize and put forward thoughts for the development of wireless transmission technologies.

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2. Long-range wireless communication technology.

2.1. GPRS/GSM wireless communication.

General Packet Radio Service, sometimes known as GPRS, is a mobile data service that GSM mobile phone users can access. It is a member of the second generation of mobile communication data transfer technologies. Packet exchange encapsulates the data into many independent packets, and then transmits these packets one by one, which is a bit similar to sending packages in form. Its advantage is that it will occupy the bandwidth when there is data that needs to be transmitted, and it is priced by the amount of data, effectively improving the utilization rate of the network. The third generation of mobile communication networks is built on the technical foundation of CDMA (Code Division Multiple Access). Due to its properties of easy frequency planning, big system capacity, high-frequency combining coefficient, powerful resistance to multipath interference good signal quality, soft capacity, and soft switching, CDMA system exhibits significant development potential [2]. CDMA exists because communication operators need to share the same frequency band for multiple users in order to provide services to as many users as possible. At this point, it is possible to distinguish each user's call channel by using a special symbol called a pseudorandom noise code.

2.2. Data radio communication

Data transmission radio refers to the data transmission station working in the working frequency band in VHF and UHF. The transmission power is between several watts and tens of watts. The transmission rate is between 300 and 19,200 bps, and the coverage distance is dozens of kilometers. Digital transmission stations often use high performance and high reliability technologies such as surface chip integrated design, software radio, digital modulation and demodulation, and digital signal processing. [3]. Direct connections to equipment like laptops, collectors of data, RTUs, PLCs, data terminals, GPS receivers, photographic equipment, and other devices are possible thanks to the widespread RS-232 data interface that is frequently provided by data transmission stations. It has been extensively applied to numerous industries, including those in the aerospace, railroad, power generation, petroleum-based products, weather studies, natural disasters, etc. Additionally, it has advanced significantly in SCADA-related sectors such remote control, telemetry, remote signaling, and sensing from afar.

2.3. Microwave spread spectrum communication.

Spread spectrum technology, also known as spread spectrum communication, is a method of communication in which the bandwidth of the electromagnetic signal utilized for transmitting information is substantially greater than that of the information that is being conveyed. Military communications were its initial application. In order to achieve spectrum expansion, the fundamental principle of its transmission is to modulate the transmitted information with a pseudo-random code sequence (spread spectrum code). The rate of the pseudo-random code is much higher than the rate of transferring information, and the bandwidth occupied by the transmitted signal is far greater than the bandwidth required by the information itself. The communication system composed of microwave spread spectrum communication technology has a series of advantages that other systems cannot match, which solves the four major problems of interference, leakage, site selection, and networking in various contemporary wireless communication systems and has made breakthroughs in many aspects that have been valued and applied by all walks of life [4].

2.4. Wireless bridge

A wireless bridge is the communication link between two or more networks that is created by a wireless network via wireless transmission. In addition to the basic characteristics of wired bridges, wireless bridges operate in the 2.4G or 5.8G wireless license-free frequency band, so they are more convenient to deploy than other wired network equipment. When utilized for long-distance (up to 50 km) and rapid connectivity (up to 100 Mbps) wireless networking among fixed digital electronics and

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other stabilized digital equipment, it is a type of memory and processing device that realizes LAN connections at the link layer. Wireless bridge transmission technology can achieve stable transmission of signals under land and sea transmission conditions [5].

2.5. Satellite communications

Satellite communication uses synthetic globe satellites as a relay station to transmit radio signals in order to achieve communication between several ground stations. Satellite communication is the continuation and progress of ground microwave communication. The communication system is made up of a management and surveillance components, a tracking telematics and command component, a communication earth terminal subsystem, and a satellite subsystem.(collectively known as the tracking telemetry remote control and monitoring (TTC&M) subsystem) and a communication business control center. Its advantages are wide coverage, long information transmission distance, the ability to realize multiple access communication, with a wide frequency band and large communication capacity, high-quality, high-stability lines [6].

2.6. Shortwave communication

Electromagnetic waves having a wavelength of 100 m to 10 m and a frequency of 3 MHz to 30 MHz are referred to as short wave. Short-wave radio communication, sometimes referred to as high-frequency (HF) radio communication, is referred to as short-wave communication. The technical advantages of short-wave communication are good communication reliability, high data transmission speed, strong anti-interference ability and grid advantages [7]. The two types of shortwave communication are sky wave propagation and ground wave propagation. With an increase in operating frequency, ground wave propagation attenuation rises, and given the same ground conditions, the higher the frequency, the larger the decay. Weather has less of an impact on earth wave propagation, and it is generally stable. Skywave propagation is a method of long-distance communication that uses radio waves that are reflected by the ionosphere. After being reflected by the ionosphere, the obliquely projected electromagnetic waves can be relayed to the ground thousands of kilometers away. Sky waves can be used for global communication because they have significantly lower propagation losses than ground waves and can travel to incredibly remote locations after many reflections between the earth and the ionosphere.

3. Short-range wireless communication technology.

3.1. Zig-bee

Founded on the IEEE802.15.4 standard, Zig-Bee is a short-range, low-energy wireless communication system. From bottom to top, the Zig Bee protocol consists of the physical layer, MAC layer, network layer, safeguards layer, and application layer. The network layer, application layer, and security-related services are defined by the Zig Bee Alliance, while the physical and MAC levels are described by IEEE 802.15.4. [8]. The technical characteristics of Zig-Bee are multi-band, multi-rate, strong transmission reliability, a large number of network nodes, low transmission power consumption, low cost, high transmission security and flexible self-configuration [9].

3.2. Bluetooth

A particular short-range wireless connection allowing stationary and mobile devices to build a communication environment is the foundation of Bluetooth technology, a global protocol for the onset of wireless data and voice communication [10]. In reality, there are various "categories" of Bluetooth technology, or distinct iterations of the fundamental specification. Currently, the most widely used Bluetooth technologies are Bluetooth BR/EDR (basic rate/enhanced data rate), which is primarily used in Bluetooth 2.0/2.1 versions of products like speakers and headphones, and Bluetooth with reduced energy (Bluetooth Low Energy) technology, which is primarily used in the newest products on the market like necklaces, home automation systems, automotive electronics, and medical devices.

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3.3. Wi-Fi

An 802.11-based wireless LAN access technique is known as Wi-Fi. The fact that (Wi-Fi) technology provides extensive LAN coverage is by far its greatest benefit. The range of its coverage is around 100 meters. Wi-Fi's coverage is greater than Bluetooth's, and it transmits data at speeds of up to 11 Mbps (802.11b) or 54 Mbps (802.11a), which makes it ideal for rapid connectivity data transmission services. It is ideal for the demands of cellular office workers because wire is not required and speed is not constrained by wiring restrictions. According to the different coverage, radio access technologies can be divided into three categories: local radio access network (WLAN), metropolitan area radio access network (WMAN) and wide area radio access network (WWAN). Among them, WiMAX technology spans WWAN and WMAN, and early WiMAX technology does not support mobility; support for mobility is gradually added in later standards [11].

3.4. UWB

UWB is a carrier-free communication technology. It transmits data using narrow, non-sinusoidal pulses on the nanosecond to the picosecond scale. Its transmission distance is usually within 10m. More than 1GHz of bandwidth is used by UWB, and its maximum data throughput is hundreds of megabits per second. UWB can operate in the frequency range of 3.1GHz to 10.6GHz. 500MHz is the bare minimum working bandwidth. The benefits of inexpensive prices and low energy consumption, as well as improved information transmission efficiency when compared with classical carrier modulation technology, more than offset the drawbacks of conventional wireless technology [12].

This tool can be used to find faults in underground cables and other types of pipelines, as well as to check for defects in asphalt and other construction structures in buildings, bridges, highways, and other projects. It can also be used to detect illnesses. Additionally, it is utilized in a variety of industries, including rescue efforts, public security prevention, suppression of fires, medical treatment, and medical image processing.

3.5. NFC

The transmission distance of NFC, which uses the 13.56 MHz frequency band and mixes touch-free sensing and wireless connection technologies, is around 10 cm [13]. NFC is an electromagnetic energy extraction method with a limited range that combines point-to-point communication, inductive readers, and inductive cards on a single chip. NFC allows for the transmission of electrical information among equipment which are a few millimeters apart using radio waves. It operates independently of the Internet, eliminates potential sources of interference, is mostly used in consumer electronic devices to communicate with each other, and is now almost standard technology in smartphones [14]. The five segments that follow can be used to categorize NFC application scenarios:

A. Access: NFC technology is mainly used for conference admission, traffic checkpoints, access control and event tickets. It can help people check tickets quickly and pass through the gate.

B. Payment: NFC technology is widely used in mobile phone payments, such as bus cards, subway card identification and e-wallets. This improves the efficiency of citizens' use of public transportation and facilitates people's shopping.

C. Transfer data: 2 NFC-enabled devices enable point-to-point transmission of data. This provides a quick way to transfer data between devices.

D. View information: Through NFC mobile phones, users may comprehend and utilize the features and services offered by the system. For example, with the recently popular NFC music wall, mobile phones can play music with a touch. This makes listening to music more fun and physical interactions more imaginative.

4. Conclusion.

This essay examines the long- and short-range wireless communication technologies, and it also provides a list of the most popular ones. The inferences that can be made are as follows: The development potential of communications via satellite in terms of broadband access, airborne

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communication, maritime communication, repeater backhaul technology, and satellite Internet of Things is enormous. Low-power networks are primarily the development trend for short-range wireless transmission technologies. NFC technology has a lot of playability, users can design some NFC recognition scenarios by themselves, may become more popular in people's daily life. There are also some shortcomings in the research in this paper: Only some technologies are selected as research objects, which is not comprehensive enough.Wireless transmission technology will definitely have greater development and broader applications in the future.

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